Pixels for CDFII in Run IIb

Precision tracking in the high radiation collider environment for a Higgs discovery at the Tevatron before LHC turn-on.

- ## Pixels provide advantages
  - radiation hard to ~30 fb-1 vs ~10 fb-1 for strips (Layer00 radius 3 times as harsh as Layer 0 radius)
  - large S/N (noise ~100 e- vs ~2500 e-)
  - pattern recognition: 3.3 M channels vs 14 K channels
  - z resolution 60-120 μm possible

- ## Pixels are feasible
  - ATLAS-style sensors in production
  - FPIX readout chip in advanced prototype
  - cost and schedule can be made to fit into RunIIb plans

- ## Keep strip option as a fallback

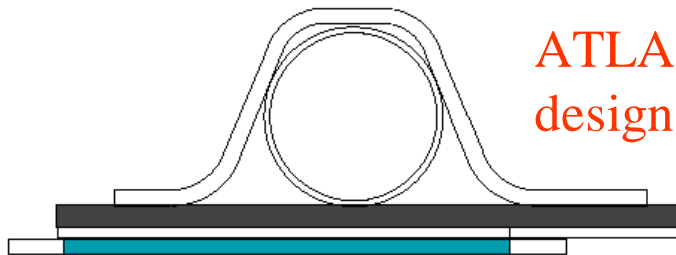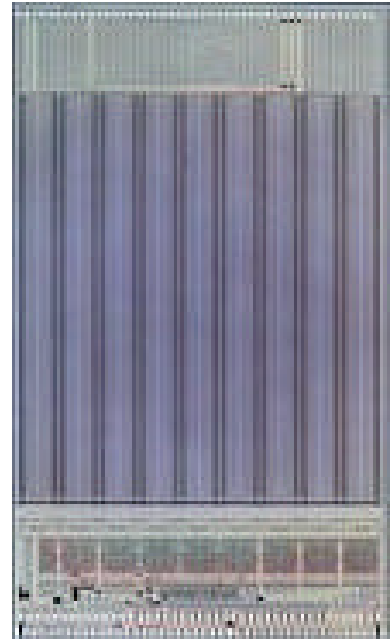- ## Overlap with BTeV and D0

Pixels are the preferred technology and they are available to us. CDF needs to decide soon (Jan. (2001) whether to pursue this option for RunIIb.
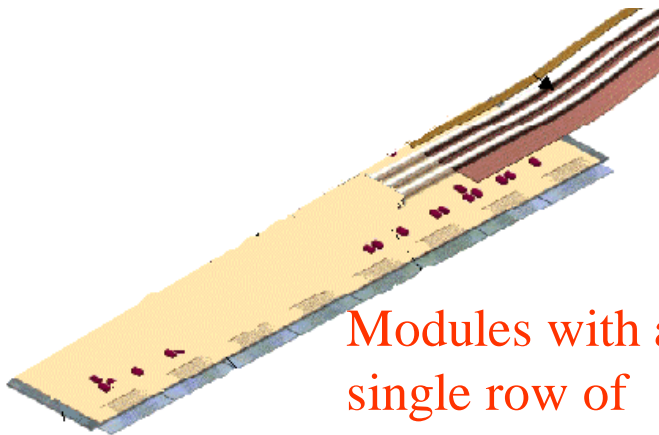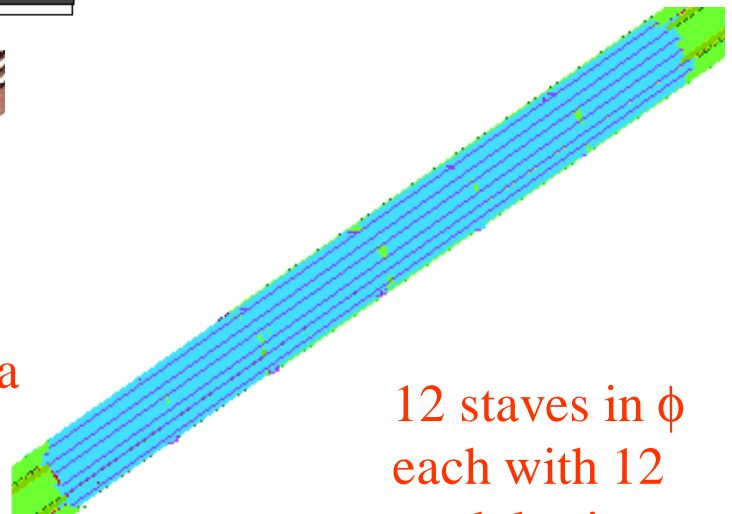
Pixel concept

ATLAS WAFER
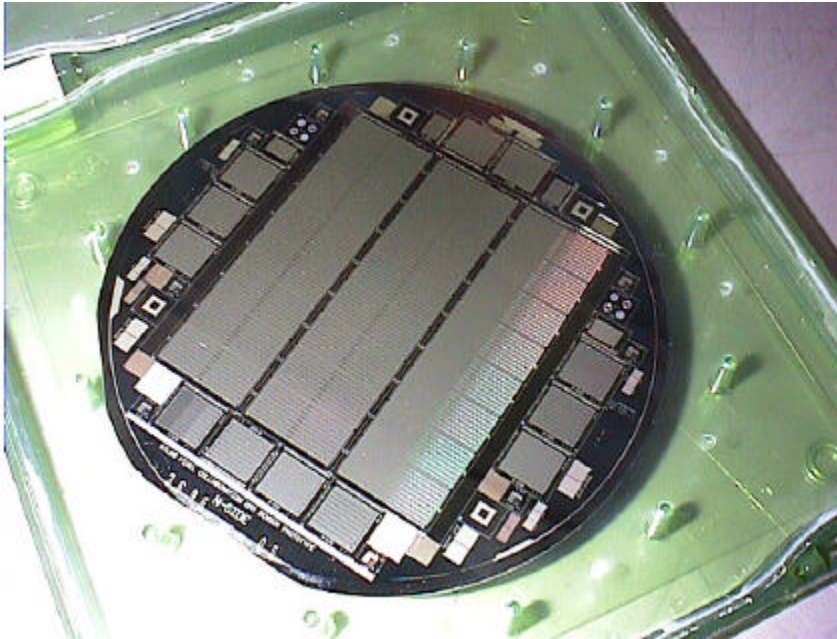
FPIX1 chip

ATLAS stave
design

Modules with a
single row of
8 chips

12 staves in ϕ
each with 12
modules in r-z

Pixel concept

Channel Count

Pixel cell	50 μm x 400 μm	1 channel
Pixel cell (between readout chips)	50 μm x 600 μm	1 channel
FPIX chip	18 columns x 160 rows	2,880 channels
Sensor/Module	single row of 8 FPIX chips	23,040 channels
Ring	12 modules in φ	276,480 channels
Complete detector	12 rings along z	3, 317,760 channels

Mechanical

FPIX chip	total area (assumes 3mm for periphery and bonding pads+100μm all around)	0.82 cm x 0.77 cm
FPIX chip	thickness	280 μm
Sensor	active area	0.8 cm x 5.90 cm
Sensor	total area (assumes 1mm guard ring)	1 cm x 6.10 cm
Sensor	thickness	280 μm
Sensor	inner layer innermost radius (closest surface to beam pipe)	1.33 cm
Sensor	outer layer innermost radius	1.60 cm
Detector	length in z (assumes 1.5mm between modules)	75cm
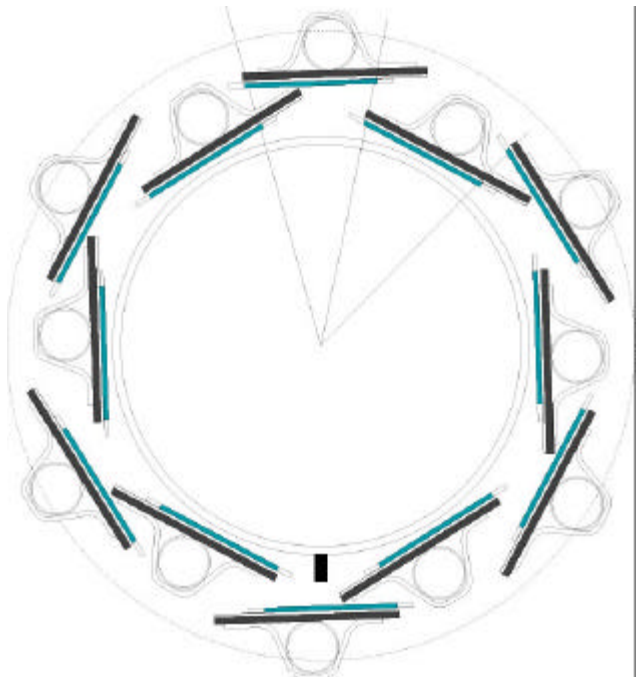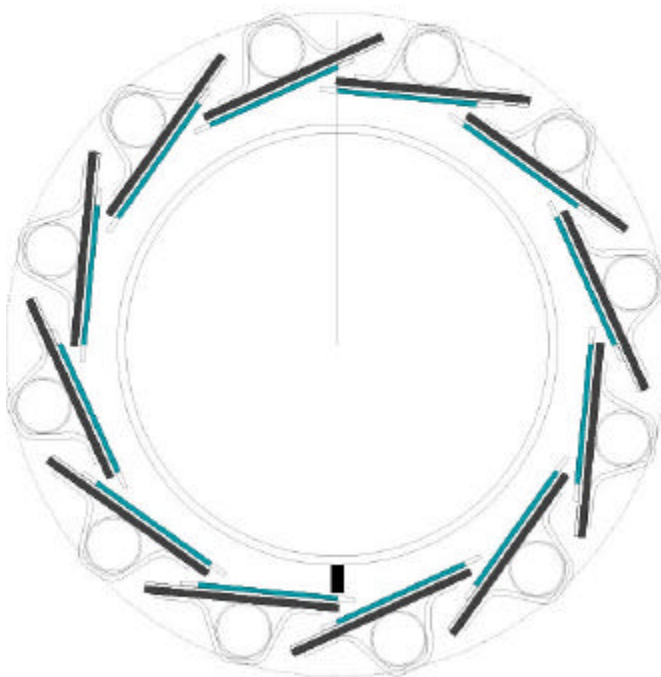
Pixel concept

- Hits stored in cell
- Readout via column logic
- FPIX sends data to a pixel port card (serialized?)
- optical link to a pixel-FIB
- FIB controls pixels and receives data in a deep memory module, time orders hits, matches to L1 accept, sends data to VRB.
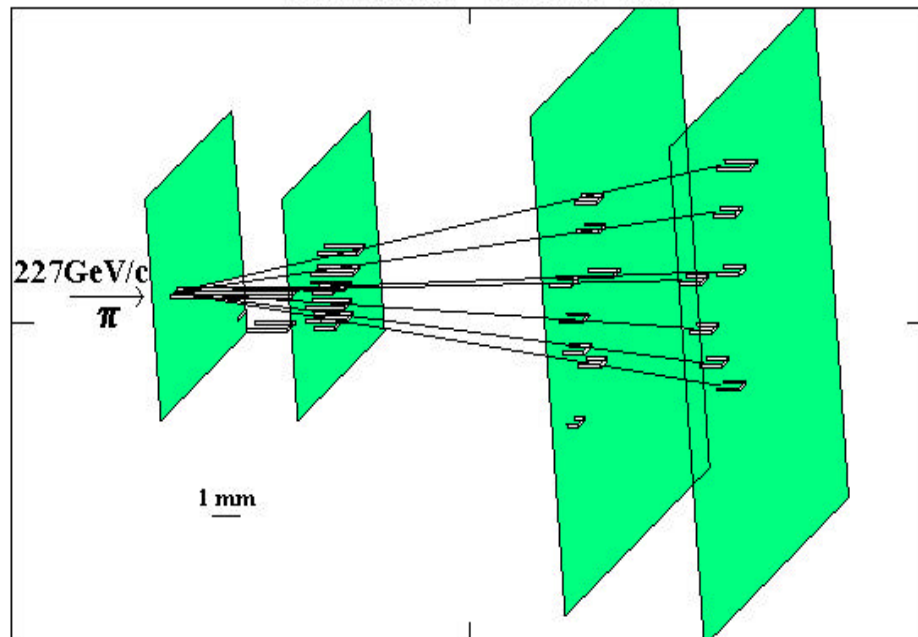- Concept exists that pixel-FIB combines hits into "strips" for SVT trigger

Testbeam results
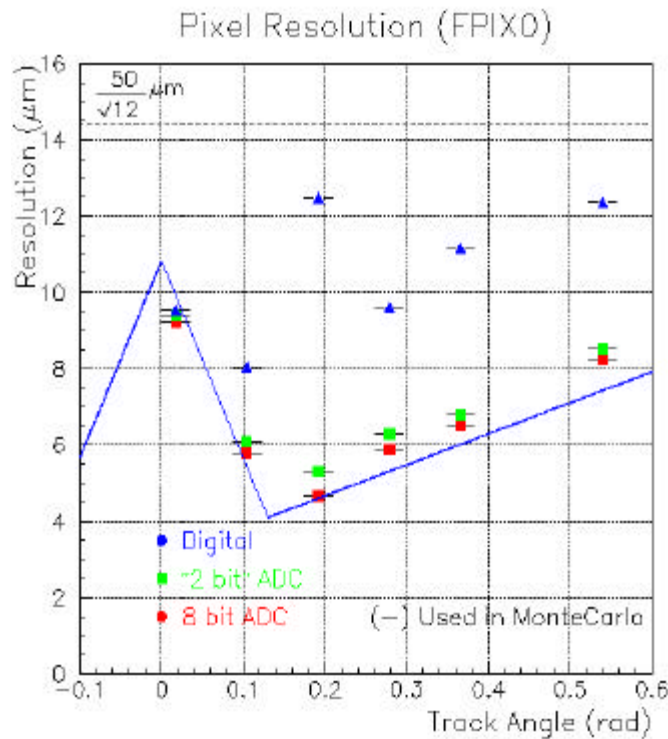
Position resolution
better than 8 μm
for most track angles

Large S/N~100 allows
for better centroid
finding

Cost

Overlaps with BTeV 10% scale test

Sensors (6 sensors/wafer)
   (prototypes at $5.5K, production $2.5K)
Readout chip wafers (200 chips/wafer)
   (first 10 at $161K, next 10 at $32K)
Bump bonding ~ sensor costs (UC Davis?)
DAQ development (port card, pixel-FIB)
Mechanical/cooling development (like L00)
Total CDF cost estimated at $1M

Schedule

2001: Order sensors and readout chips
       Mechanical and DAQ design ($500K)
2002: Build and test modules
       Mechanical and DAQ prototypes
2003: Build and assemble staves
       DAQ production
Oct 2003: Ready for data

D0 pixels

Ela Barberis
Meenakshi Narain
Gordon Watts

Run 2b Pixels

The Detector and Environment

- ✖ Detector Specification (size, geometry, etc.)
  - ✖ Pixel Detector Properties
  - ✖ Cabling
  - ✖ Cooling
- ✖ Resolution & Occupancy Calculations
- ✖ Readout
  - ✖ Triggering
  - ✖ Pixel Readout Issues
- ✖ Schedule & Cost

Group Activities & References

- ✖ Run2b Review Panel
- ✖ Talks Given
  - ✖ Pixel Update - 9/15/00 Run2b Meeting
  - ✖ Pixel Readout Development & Status -- 9/1/00 Run 2b Meeting
  - ✖ Inner Pixels -- General Proposal 6/21/00 Run 2b Meeting
  - ✖ Pixels -- General Intro Talk given by W. Wester 4/14/00 Run 2b Meeting
- ✖ Documents
  - ✖ Full BTeV PAC Proposal (Pixels are in chapter 4, starting on page 61)
  - ✖ ATLAS Pixel TDR
  - ✖ Inner Tracker and L1 Trigger Based on Pixel Detectors for D033 (D0 Note 3409)
  - ✖ Very initial version of CDF Pixel expression of intent
- ✖ Other Home Pages
  - ✖ CDF Run2b Pixel Home Page
  - ✖ Fermilab Pixel Group Home Page
  - ✖ D0 Run 2 Silicon Home Page
  - ✖ ATLAS Pixel Home Page

Home D0 Run 2B

Agenda for today

Overview: W Wester (Fermilab)

ATLAS-style sensors: I Gorelov (U New Mexico)

FPIX and rad hard vertex group plans: D Christian (Fermilab)

Mechanical concept and issues: D Pellett (UC Davis)

Physics studies update: D Pellett (UC Davis)

Updated proposal draft: W Wester (Fermilab)

Discussion -- what additional information should we focus on providing for the CDF review/PAC presentation.